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# DEVELOPING AN ECOLOGY OF MIND IN DESIGN

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## ABSTRACT

The relationship between design and sustainability (DfS) is forever evolving: from the early focus on cleaner production processes and resource efficiencies to more recent endeavours to promote environmentally benign behaviours or to counter the increasing impacts of climate change. The uncomfortable truth though is that the majority of design activity serves market forces at a global scale and at an ever-increasing rate. Despite predictions of resource scarcity – *peak* oil, *peak* minerals, *peak* water – the increase in the linear transit of material through the Global economy rises year on year. Design straddles this production consumption cycle: it conceives of the processes and technologies that shape our artificial world; and it fashions the forms of that artificial world that drive a consumption ideology. Neither position is sustainable. Informed by Sterling's rigorous exploration of different sustainable education paradigms, this paper reconstructs a design literacy that has the capacity to realize effective transitions for the long-term wellbeing of environment, biodiversity and humankind.

*Keywords: design for sustainability, ecoliteracy, transformative learning, sustainable education*

## 1 INTRODUCTION

The prominent anthropologist and systems thinker, Gregory Bateson, notably said that *the world partly becomes - comes to be - how it is imagined* [1]. This is an important point for designers and design educators to recognize as designers play a central role in imagining our artificial world. The products, buildings, the processes behind them, the information about them, the ways in which we interact with them and so on – all of these things have a design input. In the process of industrialization these inputs have been valued and used widely to multiply the amount of goods and the desirability of those goods across global markets. This production and consumption dynamic is out-dated in a world of depleting, accessible natural resource and an inequitable distribution of that available resource. Design, situated in the middle of this production-consumption cycle, needs to imagine an otherness – one that responds to ecological limits while meeting peoples' needs equitably, in inspiring and hopeful ways.

As educationalists we should question the value of educating designers to operate in a defunct system that ramify the effects of an old mode of thinking, and instead, educate them to embrace new habits and behaviours. If we persevere with old ideas we grow a crisis of imagination in all types of education and specifically, design education. It is vital to understand the need to re-imagine our ways of design thinking and practice, the processes of how to re-imagine and the potential of what we can imagine. We need new language, new concepts and radical change, and it is these components that need to be effectively integrated into different educational approaches. This paper explores the degree to which the concept of sustainability is currently integrated within society and specifically, education. It explores the links between design and sustainability in terms of education practice and, informed by the extensive work on sustainable education paradigms by Stephen Sterling, suggests a new form of design learning, one that resonates with an ecological and participatory worldview.

## 2 THE LIMITS OF 'SUSTAINABILITY'

Unsustainability exists because of ill-conceived relationships between humans, large complex systems and the scale at which such relationships exist. The *root problem* in these relationships is the indiscriminate technical use of nature by humankind [2]. Responses to the state of unsustainability are

many and varied, but most are described as *sustainable* policies or activities. Sustainability is widely understood as a three-pronged approach that splits up the sustainability agenda into the different elements of economy, environment and society. Each element is diagrammatically given equal weight in the form of a Venn diagram (see Figure 1) and the emphasis is on a balance between all three elements to deliver more sustainable forms of behaviour and output. This framework, termed the *Triple Bottom Line* (TBL), was established in the nineteen-nineties [3] and proved a useful tool to engage organizations and Government in integrating increasing environmental demands within their operating structures. It provided a conduit to discuss environmental issues, which until then had been a rather marginalised agenda. TBL brought sustainability to the mainstream and to a more corporate audience. Today sustainability is a common term, overly used and non-specific; people discuss sustainability in terms of environmental degradation and yet equally refer to it in the context of economic resilience. These are two very different things.

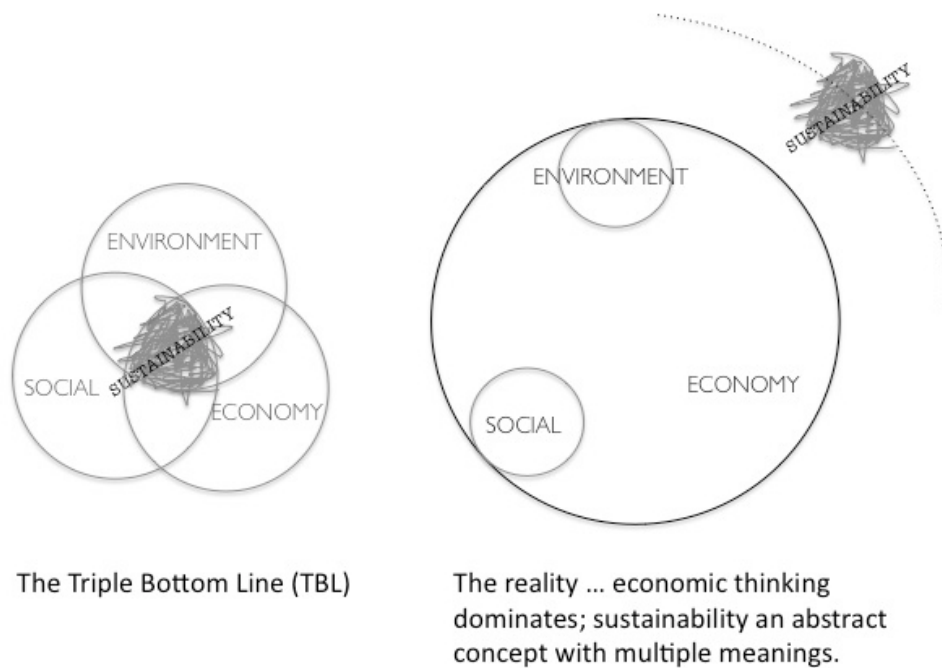


Figure 1 Diagrams of Sustainability

The *reality* of the balanced TBL Venn diagram, as shown in the right hand side of Figure 1, is one where economic decisions dominate activity and the systems driven by such thinking permeate the way we live ... and the way we learn and teach; environmental and social considerations are viewed as an 'add-on' to our traditional economic system and sustainability is an abstract concept that is difficult to define and deliver on. By splitting sustainability into parts, people rationalize sustainability and decide to deal with one aspect or part, often in isolation from other connected parts, and as a result a disjointed picture evolves.

Dealing with unsustainability 'in parts' isn't a rigorous enough strategy to cope with the trauma we have already bought based on the climatic impacts of human activities to date. Scientific data predicts we will see temperature rises of between 1.8°C and 6°C on 1990 temperatures by 2100, the median rise being 3°C [4]. At that median temperature rise there will be several discontinuities such as a 30% loss of coastal wetlands, the extinction of 15-40% of endemic species in global diversity hotspots, a loss of between 20 to 80% of the Amazon rainforest and its biodiversity and 3.2 billion people affected by decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes [5]. These increases, coupled with the subsequent ecological positive feedback loops associated with temperature increases, will significantly disrupt food, goods and utility supplies the world over.

The current view and level of integration of sustainability within the language and activities of industrialized nations is insufficiently distilled for new types of goals, visions and strategies to evolve to adequately respond to long-term human resilience given the increasing impacts on our ecological

support system. For example, many engineers state we have a wide range of existing technologies that can deliver a lower carbon economy; the problem has not been a lack of innovation and technology but rather a lack of policy and new technology adoption [6]. This is a top-down view. We can also look at this from a bottom up approach and recognize that the unsustainable levels of resource throughput in the rich, industrialized nations' economies is not only a problem of policy but also one of people; of their expectations for a quality of life predominately met through high levels of consumption.

## 2.1 A changing landscape for design

John Ehrenfeld posits a useful distinction between *reducing unsustainability* and *creating sustainability* [7]. The former is concerned with eco-efficiency – improving the environmental performance of what already exists. In design terms this translates to ecodesign activities in reducing material and energy intensities across the lifespan of design outputs. These activities connect to Donella Meadow's view of the least impacting levels of intervention in a system and focus on numbers and the auditing of stocks and flows of resources [8]. In design this equates to adjustments to a product, process or system, addressing for example, quantitative, measurable improvements in efficiency, or new legislative requirements. Designers and engineers have traditionally tackled the "environment" at this level; they have been taught to do so. However, if we return to Bateson's suggestion that the world comes to be as it is imagined and understand that designers play a role in such imaginings, we can ourselves imagine that the concept of reducing unsustainability holds limited potential for designers to contribute to real and effective sustainable change. Instead, Ehrenfeld argues, there is a requirement for a new pattern of thinking; a pattern that is about *creating sustainability*, and about reshaping the rules of the system. This requires designers and engineers to think beyond their discipline and understand important connections to other ways of working and delivering different types of outcome. Meadows similarly suggests that the most impactful interventions in a system will arise from changes in the existing paradigm or mindset of that society: for us today this would equate to deep challenges in the way in which we perceive of, and use, natural resources.

Both Ehrenfeld and Meadows help paint a diverse landscape of the scale and scope of new types of thought and activities required for design for sustainability. This landscape is new and unfamiliar landscape that addresses ideas of resilience for the long-term and the survival and flourishing of human and non-human alike. To address 'real-world' problems - poverty, poor health, water shortages, food insecurities, fuel poverty, diminishing oil supplies, deforestation, soil erosion and inequitable resource distribution – it will be critical to educate people to recognise ecological limits and to live and work intelligently within them.

This approach is in stark contrast to current economic models that encourage linear resource flow and perpetual growth. A transition to a new operating paradigm requires a reconfiguration from the economic to ecological boundary as the true parameter of decision-making. Rotmans *et al* [9] state that a transition is "... a set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems ...". And in relation to different ways of thinking Ehrenfeld [10] adds "As long as we continue to hold our current beliefs as immutable, we cannot change the basic patterns of life that have become unsustainable. [...] We do, however, have power to change what we mean by reality and rationality by adopting a different approach regarding how we perceive worldly phenomena and then converting our perceptions into action." Design interventions for effective sustainability embrace both interconnectedness (from technology and economy to personal behaviours, beliefs and the ecological limits of a system) and human capabilities to imagine different ways of being and acting in the world. Education in this transition needs to build capacity to visualise these different horizons and the components of them; it must find a way of navigating a challenging landscape.

## 3 SUSTAINABLE EDUCATION

The debate concerning how to educate for sustainability resides in many disciplines. Many consider that a trans-disciplinary approach to sustainable education is likely to be the most effective [11]. Over a decade ago I was involved in a research project, DEMI (design for environment multi-media implementation), the aim of which was to respond to the gaps and opportunities in the provision of sustainable development education identified by the Government's Sustainable Education Panel and

Forum for the Future. A position paper from that panel [12] outlined curriculum themes for design education, namely sustainability concepts (Table 1), sustainability solutions and the development of effective teaching strategies to aid these goals.

*Table 1 The sustainability concepts learners should understand at the end of their design programmes*

| Key concept                                       | Description  |
|---|--|
| <b>The interdependence of major systems</b>       | The role of natural systems in maintaining an environment which can support life<br>The relationship between health of the natural environment and living conditions of people<br>The relationship between poverty, population, consumption and the degradation of the global environment<br>The need for sustainable natural, social and economic systems to secure sustainable development     |
| <b>The needs and rights of future generations</b> | The legacy of the past in relation to current levels of social, economic and environmental sustainability<br>The need for conservation, efficiency and restraint in consumption and resource use<br>The need for long-term thinking / vision<br>The implications for future generations of different development routes [e.g. globalised v localized; high-tech v low-tech; consumer v conserver |
| <b>The value of diversity</b>                     | The relationship between the diversity of human systems – cultural, social, and economic – and of natural systems (biodiversity)<br>Reasons for the loss of diversity (cultural and biological)<br>The rationale for protecting biodiversity   |
| <b>The need for precaution</b>                    | The uncertain nature of knowledge in relation to sustainable development<br>The need for critical thinking, systems thinking and life-long learning in response to uncertainty and the complexity of sustainable development issues<br>The nature of and need for the precautionary principle in relation to action at individual and collective levels  |
| <b>Limits to growth</b>                           | Alternative perceptions of growth and development<br>The meaning of terms “carrying capacity” and “ecological footprint”<br>The consequences of exceeding carrying capacity<br>The current reliance of the world economy on fossil fuels and the prospect for alternatives   |

DEMI aimed to design the detail of this learning framework and disseminate it as an internet resource. Since that time the DEMI learning map has been utilised in Higher Education design courses but not as extensively as originally hoped and there are perhaps two good reasons for this: 1 it is difficult to introduce a new way of design thinking via an ‘early innovation’ in multi-media teaching [the technology for integrated participation wasn’t widely available at the time where co-creation and participatory learning are important elements based on the author’s own experience of teaching ecodesign in traditional, face-to-face environments]; 2. Evidence from those courses participating in the project showed that DEMI was predominately used as a support tool for existing teaching – as a way of introducing new information and teaching *about* sustainability. I will return to the limits of this approach later on.

While DEMI may have succeeded in communicating knowledge about sustainability it failed to transform design learning to challenge the core focus of market-driven design activity. In a paper presented to this conference four years ago the reasons why sustainable education in design has had limited affect were explored [13]:

1. Current curricula tend to be discipline based. Sustainable development on the other hand is a trans-disciplinary subject and requires a reflective and iterative approach to see emerging discipline links. This enables learners to contextualise the subject and to understand the perspective and scope of specific themes [14];
2. The concept of responsive, dynamic and process learning to enable a 'real' understanding of sustainable development poses a conflict with the established, pre-defined learning outcomes currently

used to measure student performance [15]; and

3. Sustainable development has been described as being too abstract [12]. To avoid such claims it is important to promote an educational philosophy that connects everyday living to the more generic policy objectives. This is encouraged through local ownership of learning - both content and process - and is something that can't be governed 'centrally' through rigidly defined curricula content and outcomes [15].'

Fundamentally there appears to be a problem with the understanding and vision of sustainable education. Our current teaching paradigm uneasily adopts strategies that aim to look at building knowledge and experiences of dealing with problems of uncertainty that span many disciplines. Rather than continue to unsuccessfully force-fit or 'add-on' such experiences to that paradigm it would appear more useful to encourage a new learning paradigm that *emphasises independence of mind and the ability to make sense of, rather than reproduce, information*' [15]. So for example, in the case of design education and the sustainability concepts described in Table 1, in preference to transmitting information about the nature of the concepts we may instead want to look at a typical product life – something owned by the learner – and ask them to reflect on the consequences and implications of that product's existence in the context of sustainability. An electronic product for example would have many materials, minerals, wastes and potential toxins associated with its production and disposal. There may be many millions of units of this product produced; it may incorporate high-end technology that is not easily repaired or maintained. What does our ownership of it mean for other groups of people in the world today; or for future generations? Will there be sufficient resource to continue producing consumer electronics at the current pace; will there be a build up of toxic wastes, if not in our lifetime, in the lifetime of others; what skills do we decrease with increasing reliance on high-tech products, etc? It is these types of questions and the process of thinking in responding to them that are important to introduce, in contrast to an emphasis on seeking out one correct response. It is the *dialogue* concerning sustainability concepts that needs to be made *real* and less abstract than a list of global issues.

### **3.1 Exploring paradigms of sustainable learning**

Educationalist, Stephen Sterling has a vast experience and knowledge of environmental education. His work on sustainable education rigorously interrogates the constraints and opportunities for introducing different types of educational philosophies in response to unsustainability [16]. Sterling argues that 'education for change' is complex and involves ambiguity and uncertainty. It is about the engagement of the individual and the whole learning institution in meeting the challenges and opportunities for change. Alternative learning strategies are required to make sense of a new learning landscape that embraces trans-disciplinary, participative, creative, constructive and responsive methods that foster new perspectives and understanding and the reflection necessary for problem reframing and capacity building. Sustainable Education is fed by a broad and trans-disciplinary heritage. Sterling ingeniously builds on this background to create a meta-paradigm view of sustainable education, coupled with an understanding of the levels of learning of each of component paradigms as shown in Figure 2.

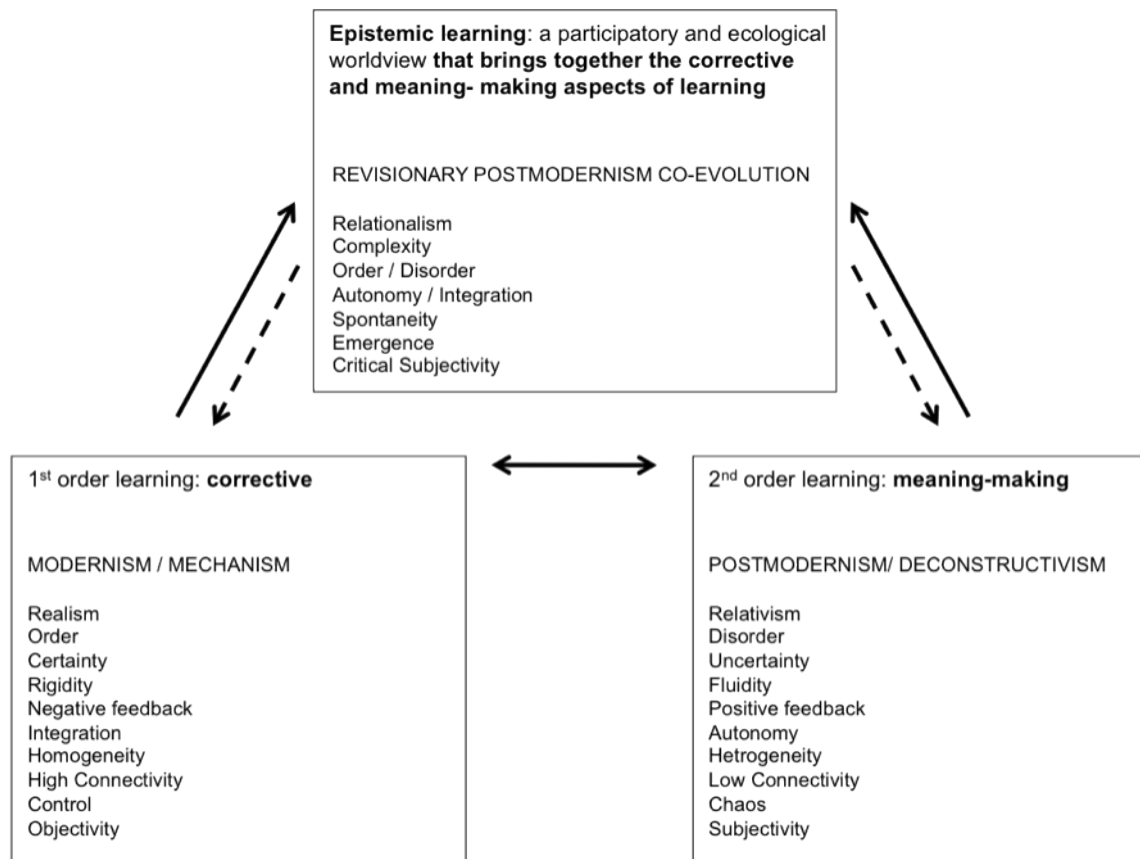
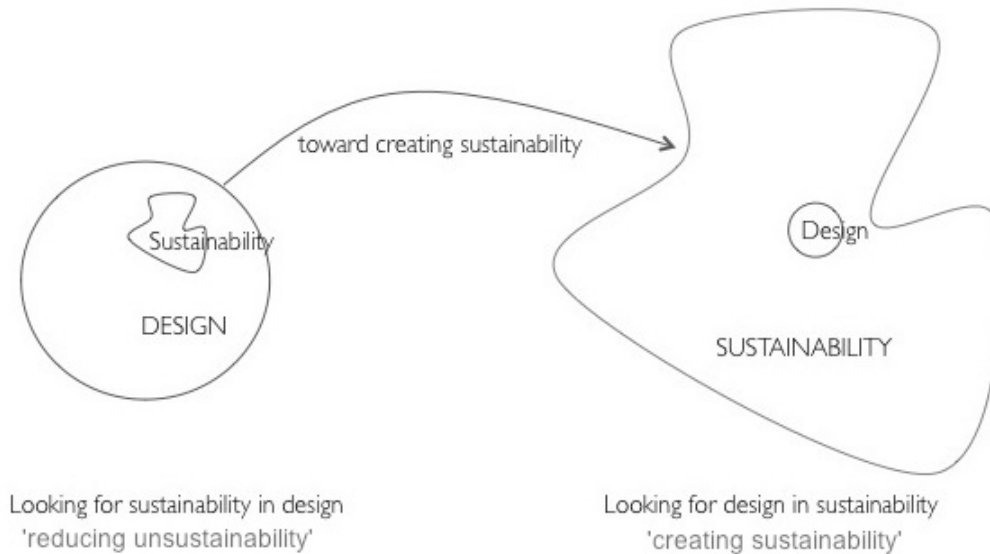


Figure 2 Three learning paradigms and three orders of learning combined from [16]

What is insightful about Sterling's work is the emphasis on interconnectivity and mutual learning across the different learning paradigms. Our current way of teaching emphasises 1<sup>st</sup> order learning: the transmission of information, which in the context of sustainability, concerns the provision of information about environment in the hope that behavioural change will follow from increasing levels of knowledge. The context of learning in this instance is informed by a rational, deterministic view that frames a modernist approach where the learning limits of this paradigm prevent it from being self aware or reflective. This results in what Ehrenfeld terms 'reducing unsustainability' – producing more of the same but slightly improved to respond to increasing degrees of environmental information. Sterling explains that *at a meta-paradigm level [...] we need to recognize the emergent and urgent shift from the mechanism, scientism, objectivism and reductionism of the dominant old paradigm, towards ecologism, holism, participativism and systemism of the new. This is a task [...] that necessarily involves epistemic, re-perception, re-cognition and realization* [16:323]. The 2<sup>nd</sup> order learning paradigm – meaning making – deconstructs the modernist approach but, in isolation, is *unable to generate sufficient meaning that gives us any guidance as to validity and worthwhileness* [16:349]. Sterling suggests a third-order change that builds both on the modernist and deconstructivist paradigms to bring together the elements of corrective and meaning-making learning in an epistemological orientation towards an ecological and relational worldview. The following section explores how this picture of sustainable education can help re-conceive design education to better *create sustainability*.

#### 4 RECONSTRUCTING DESIGN LITERACY

Limits to sustainable change through design are bounded by the limits of the system in which design operates. In creating sustainability, and particularly in creating a sustainable human ecology, the challenges for design are to deeply understand, integrate and imagine the forms of resilient societal cultures and their operations. Design can interrogate this new landscape to create new types of products, services, systems and operations that help build sustainability and help us to re-imagine our emotional connections to nature.



*Figure 3 A journey for design: from reducing unsustainability to creating sustainability;  
adapted from [17] and informed by [7]*

The majority of (design) education reflects 1<sup>st</sup> order learning – the transmission of information and skills. In figure 3 this is represented on the left hand side where sustainability is ‘added onto’ the current mode of thinking about design. Looking for sustainability in design today will allow us to produce more efficient and durable things but won’t allow us to reflect on design and its scope for transitional change. That opportunity arises with the recognition that sustainability is vast and trans-disciplinary and design, situated within this context, has the potential to reflect on its part in interpreting and acting in and on the reality around it and work towards the realization of what creating sustainability might be. Across all disciplines of design, designers utilize their inner experiences as a resource for knowledge and understanding; part of evolving a new order of learning is to build on that connectedness with the inner and outer worlds and build capability to redraw the story for society; to revision and to make real other, viable and more sustainable lifestyles. Adaptive capacity and creative resilience are cornerstones for affective sustainability and design’s potential to create sense-making of sustainability and its scope will deeply affect that resilience and hopefulness for the future.

Creating sustainability will require both imagination and rigour. Designing for a participatory ecological worldview requires design thinking that transcends a mechanistic, interventionist and control outlook to one that reflects the values of ecological systems, emergence, complexity and uncertainty. The importance of the individual, and groups of individuals, in transformative learning is the sense of personal accountability that reconnects people (designers) to their social and ecological landscapes. This process is more effective when based on personal experience, interpretation and realization. The seeing, knowing and doing that is *design literacy* is drawn from the potential of the individual to think critically, systemically and reflexively and for this potential to be further drawn upon in participatory, social learning that characterizes the meaning-making element of education for change. Informed by Sterling’s paradigmatic learning framework, a proposition for design literacy in an ecological and participative worldview is presented here in Figure 4. This learning agenda is termed *co-creating sustainability* to reflect: 1. Ehrenfeld’s idea of making the future what we can through new, alternative and resilient visions; and 2. the duality of learning from the existing, corrective learning paradigm and from a new meaning-making paradigm resonant with an ecological worldview. This does not represent a comprehensive curricula, instead it is more a signal to the shifting ideas of what it is to imagine in a world in transition and the role of design in meeting a whole set of new requirements concerning ecological and social well-being.



**[CO]CREATING SUSTAINABILITY** *A transformative learning that draws on corrective and meaning-making paradigms to develop a participatory and ecological design literacy*

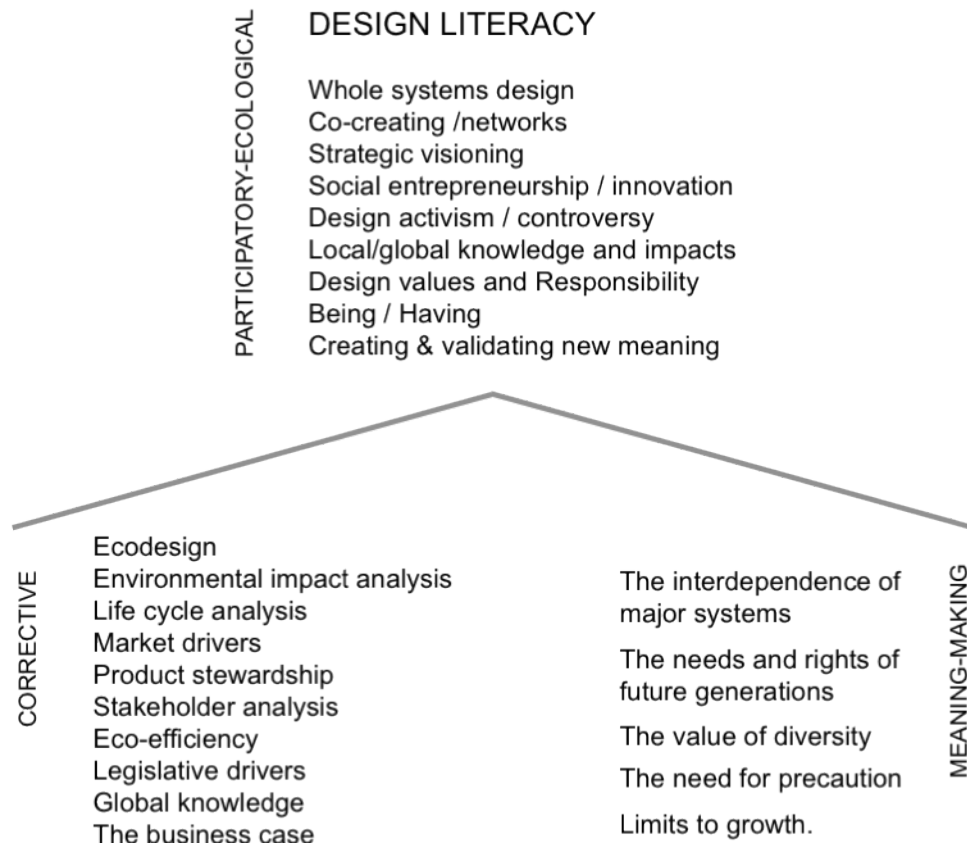


Figure 4 A proposition for a participatory and ecological design literacy: [co]creating sustainability

## 5 SIGNS OF AN ECOLOGY OF MIND

A new design literacy responds to sustainability through strategies of reframing problems, creativity, and technological innovation and also, and perhaps more importantly, by a bold willingness to consider solutions that don't conform to the current paradigm of design. This section briefly explores two stories of design that resonant with an ecological and participatory worldview.

### 5.1 PIG 05049

Dutch communications designer, Christien Meindertsma studied the afterlife of a commercially farmed pig from the Netherlands. Her idea was to explore the number of products that one pig contributes to and to audit these; to discover how wide-ranging this list would be and how dispersed geographically, and conceptually, the pig would become from its origins as a 'meat product'. Through detailed research Meindertsma discovered that Pig 05049 contributed to 185 food and non-food products, from familiar pork products to less expected ones such as an aluminium mould, a train brake, a bullet (part of the pig is used to help disperse the gunpowder), a bone china cup, a heart valve and extra calcium yogurt. Meindertsma's aim was to reconnect the storyline about where manufactured products come from. As she points out *"There are very many steps between the raw material and the end product in modern commercial production...so knowledge gets lost. (Even) the pig farmers...don't know all the end-products that are made from their pigs"* [18].



Figure 5 PIG 05049 by Christien Meindertsma

The design outputs of this project were a beautifully crafted book, each page detailing a product that is mapped to a part of Pig 05049, (Figure 5) and an exhibition that showed the range of products that used this one pig. What is unique and useful about Meindertsma's project is the way the information is made transparent to non-expert audiences. It's easy to relate to because it focuses on one pig. This is a very effective piece of communication design and lightly leads people to explore issues of ecological wellbeing and their relationship to the constructs of modern commercial farming and global manufacturing.

## 5.2 Lunar-resonant lighting

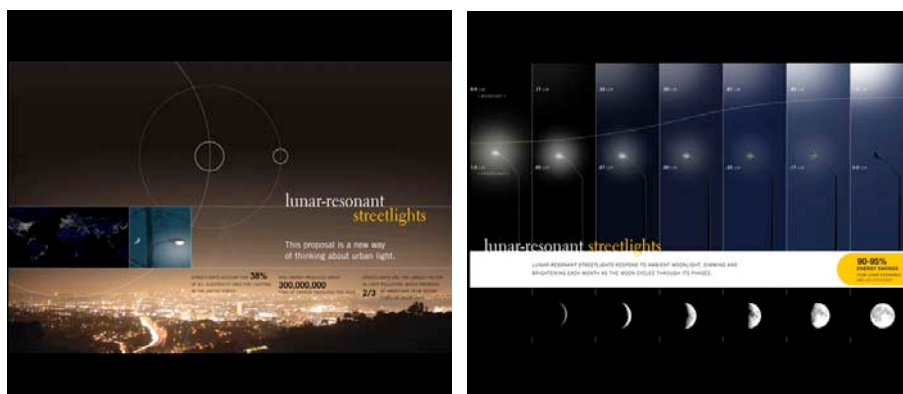


Figure 6 Lunar resonant lighting by Civic Twilight

In the 1930s, with the spread of electrification and the consolidation of utilities, streetlights provided an easy way to off-load excess energy from the grid at night, when power demands were low. This intentionally inefficient system determined the norm for nighttime outdoor lighting levels, and what we now assume is a safety measure is instead the legacy of an obsolete energy practice. A design collective called Civic Twilight from San Francisco focused their efforts on considering this issue. They recognized that night lighting accounts for over a third of the electricity used for lighting in the United States: that's close to 300 million tons of carbon emissions a year. Such intensive levels of lighting can also significantly disrupt nocturnal life and prevent people from seeing and appreciating the night sky. They designed a system of lunar-resonant streetlights (Figure 6) that has the potential to save 80–90 percent of the energy used in lighting our environments at night [19]. The LED lighting technology incorporates a light sensor that can be retrofitted to existing streetlights. Not only does it offer great energy savings but it also creates the potential for the emergence of new values that promote and rekindle the relationship between humankind and our environment. We are invited to reconnect with a natural resource, the night sky, which we had perhaps forgotten. This project represents an ecological intelligence much needed in design thinking and practice.

## 6 CONCLUDING REMARKS

In the process of shifting mindsets, uncertainties must be expected along the way. To place less emphasis on the boundary setting device of the profit imperative in current design and engineering

practice and move towards a landscape where different fundamental values and practices exist, is ultimately to challenge the core of what it is to be an engineer or a designer today. These are big steps. Can I neatly define the pathway of such a transition? No I cannot. Nor can I explain the detail of the learning and practice that exists in this new and emerging landscape. What can be explored however is the development of new thinking and practice that connects to the ecological whole and responds to the need to shift up a gear towards delivering greater resource productivity. So what can we surmise about an ecology of mind and how can this new journey take shape for designers and engineers today? Firstly it is important to recognise that different types of learning and knowledge inform a useful pathway for ecological design thinking. Large, meta problems and concepts such as limits to growth and the precautionary principle need to be usefully aligned to everyday practice through skills and tools such as approaches to lifecycle and stakeholder analysis to create new meanings that inform an expansive literacy of design. Secondly, it is not just the subject or content of design that evolves to respond to ecological boundaries but also the processes of thinking that informs design. With increasing uncertainty and complexity there is a need for a flexibility and responsiveness in design thought and practice. A capacity to adapt and be responsive comes from a strategic (systems) view of design and engineering and its capacity to deliver new and alternative outcomes. These outcomes may evolve from a collective response to problems (e.g. co-created outputs); they may emerge as a result of 'collisions' with existing values and ways of doing things (e.g. design activism, social innovation and entrepreneurship). It is in this reframing of design and engineering capacity that more radical responses to dramatic increases in resource productivity can flourish and new strategic relationships between people, ecology and the material world can be cultivated. These are the challenges of our time and of our design and engineering learning and practice.

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